

WHAT IS CLAIMED IS:

1. A carbon nanotube manufacturing apparatus having an aligned growth means for causing an aligned growth of a plurality of carbon nanotubes quasi-vertically on a growth substrate,

wherein said aligned growth means comprises:

an ionizing means for ionizing the vaporized gas of a predetermined carbon-containing compound;

an electric field generating means for generating an electric field; and

a heating means for heating said growth substrate placed within the electric field generated by said electric field generating means, and

wherein said aligned growth means is adapted to cause the vaporized gas of said carbon-containing compound, the vaporized gas being ionized by said ionizing means, to pass through an electric field generated by said electric field generating means, thereby causing the vaporized gas of said carbon-containing compound to come into contact with said growth substrate.

2. A carbon nanotube manufacturing apparatus according to claim 1, wherein said growth substrate is a substrate having a catalyst film formed on the surface of a silicon layer containing silicon or a silicon compound.

3. A carbon nanotube manufacturing apparatus according to claim 1 or claim 2,

wherein said ionizing means comprises a negative ion generator, and

wherein said negative ion generator provides electrons to the vaporized gas of said carbon-containing compound to negatively charge the vaporized gas of said carbon-containing compound.

- 5 4. A carbon nanotube manufacturing apparatus according to any one of claims 1 to 3, comprising:

a growth substrate forming means for forming said growth substrate by forming growth film on a surface of a predetermined metal substrate and forming a catalyst film on a surface of said growth film;

10 a growth film removing means, for removing said growth film after the aligned growth of carbon nanotubes by said aligned growth means; and

a substrate forming means for dissolving said metal substrate, embedding one ends of said carbon nanotubes disposed on the surface of said metal substrate in said metal substrate, and then solidifying said metal substrate.

- 15 5. A carbon nanotube manufacturing apparatus according to any one of claims 1 to 3, comprising:

a growth substrate forming means for forming a catalyst film on a surface of a silicon substrate to form said growth substrate;

a metal substrate forming means for inserting the tips of said carbon nanotubes into molten metal after the aligned growth of carbon nanotubes by said aligned growth means, and thereafter solidifying said metal, to thereby form a metal substrate; and

25 a separating means for separating said carbon nanotubes from said silicon substrate.

6. A carbon nanotube manufacturing method, comprising:

a growth film formation step for forming a growth film on a surface of a predetermined metal substrate;

5 a catalyst film formation step for forming a catalyst film formed from a predetermined catalyst on the surface of said growth film formed in said growth film formation step;

an aligned growth step for causing an aligned growth of a plurality of carbon nanotubes on the surface of said metal substrate through said growth film, by causing a catalytic reaction between
10 said catalyst forming said catalyst film formed by said catalyst film formation step and the vaporized gas of a predetermined carbon-containing compound;

a growth film removal step for removing said growth film to dispose, on the surface of said metal substrate, said carbon
15 nanotubes alignedly grown by said aligned growth step; and

a substrate formation step for dissolving said metal substrate, embedding one end of each of said carbon nanotubes disposed on the surface of said metal substrate, and thereafter solidifying said metal substrate.

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7. A carbon nanotube manufacturing method, comprising:

a catalyst film formation step for forming a catalyst film formed from a predetermined catalyst on the surface of a predetermined growth substrate;

25 an aligned growth step for causing a catalytic reaction between said catalyst forming said catalyst film formed by said catalyst film formation step and the vaporized gas of a predetermined carbon-containing compound, to thereby cause an aligned growth of a plurality of carbon nanotubes quasi-vertically on the surface of

said growth substrate;

5 a carbon nanotube implanting step for dissolving a predetermined metal substrate, inserting the tips of said carbon nanotubes alignedly grown by said aligned growth step into said molten metal substrate, and thereafter solidifying said metal substrate; and

a substrate separation step for separating said carbon nanotubes from said growth substrate.

10 8. A carbon nanotube manufacturing method, comprising:

a catalyst film formation step for forming a catalyst film formed from a predetermined catalyst on a surface of a predetermined growth substrate;

15 an aligned growth step for causing a catalytic reaction between said catalyst forming said catalyst film formed by said catalyst film formation step and the vaporized gas of a predetermined carbon-containing compound, to thereby cause an aligned growth of a plurality of carbon nanotubes quasi-vertically on the surface of said growth substrate;

20 a metal film vapor deposition step for vapor depositing a predetermined metal film layer on the side having the tips of said carbon nanotubes alignedly grown by said aligned growth step;

a metal layer formation step for forming a predetermined metal layer on said metal film formed by said metal film vapor deposition
25 step; and

a substrate separation step for separating said carbon nanotubes from said growth substrate.

9. A carbon nanotube manufacturing method according to claim 8,

wherein said substrate separation step comprises:

a second step of aligned growth for causing an aligned growth of said carbon nanotubes separated from said growth substrate in said substrate separation step;

5 a second step of metal layer formation for forming a predetermined metal layer on side surfaces of said carbon nanotubes alignedly grown in said second step of aligned growth and on a surface of said metal film in which rear ends of said carbon nanotubes are embedded;

10 a metal layer slicing step for slicing, in the direction perpendicular to the aligned growth of said carbon nanotubes, said metal layer formed and laminated by said second step of metal layer formation, to thereby form a slice having a predetermined thickness; and

15 a metal layer removal step for removing, in the direction of aligned growth of said carbon nanotubes, a predetermined amount of metal layer of said slice formed in said metal layer slicing step, to thereby expose a predetermined amount of said carbon nanotubes.

20 10. A carbon nanotube manufacturing apparatus according to any one of claims 6 to 9,

wherein said aligned growth step comprises:

an ionizing step for ionizing the vaporized gas of a predetermined carbon-containing compound;

25 an electric field application step for applying an electric field to the vaporized gas of said carbon-containing compound, the vaporized gas being ionized in said ionizing step; and

a heating step for heating said metal substrate or said growth substrate, and

wherein, in said electric field application step, an electric field is applied to the vaporized gas of said carbon-containing compound, the vaporized gas being ionized in said electric field application step, to bring the vaporized gas of said carbon-containing compound into contact with said metal substrate or said growth substrate, thereby causing an aligned growth of a plurality of carbon nanotubes quasi-vertically on the surface of said metal substrate or said growth substrate.